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(54) **Small volume disposable pipette tip**

(57) A pipette tip (10) has a very small volume capacity with a range of 5 to 30 microliters. The volume of the tip just exceeds the maximum of the range so as to reduce the volume of air in the system so that accuracy and reproducibility of the pipetting action is achieved. The minimum volume is achieved because of the very small inner and outer diameters of the tip stem (16) and the length of the stem (16) enables the tip to be easily inserted into a micro-centrifuge tube without the top fitting (31) contacting the tube, so as to avoid contamination.

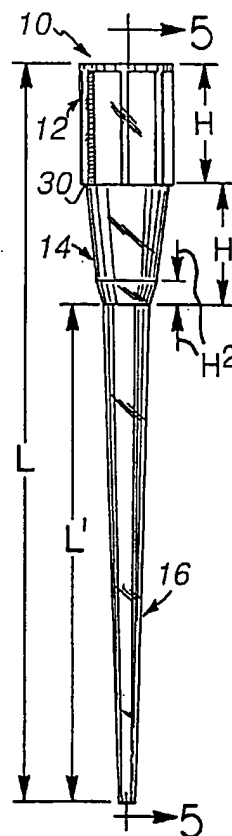


Fig. 2

Description

INTRODUCTION

This invention relates to pipetting and more particularly is directed to a pipette tip for metering very small volumes of liquid.

At the present time, there are several small volume capacity pipette tips on the market. The present invention is an improvement on the small volume capacity tips now available as it provides improved accuracy and reproducibility in metering very small volumes in the range of .5 to 30 microliters. Furthermore, the small volume capacity tip of the present invention is more convenient to use than tips of the prior art as it provides easy access into many vessels including micro-centrifuge tubes, microliter tubes and plates and electrophoresis gels, and has wider customer applications. These improvements are derived from the dimensions of the tip including the length and diameter of the tip stem, the minimum dead air space in the head and mid-section of the tip above the column of liquid drawn into the tip, and the flexibility of the tip which makes it easy to "touch off" a drop of liquid exposed at the bottom end of the stem. More specifically, the length of the stem and its small maximum diameter enable the tip stem to extend to the bottom of a micro-centrifuge tube which is conventionally as high as 1.5 inches and as small as .25 inches in diameter while minimizing the amount of liquid displaced in the vessel. The minimum head diameter of the tip also enables it to be used in a very wide variety of applications which would not be available with tips of greater diameter particularly multi-channel pipettor applications where the center to center spacing between tips must be minimized.

The invention will be better understood and appreciated from the following detailed description of the preferred embodiment thereof read in connection with the accompanying drawings in which:

BRIEF FIGURE DESCRIPTION

FIG. 1 is a top front perspective view of a pipette tip constructed in accordance with the present invention;

FIG. 2 is a side elevation view thereof;

FIG. 3 is a top plan view thereof;

FIG. 4 is a bottom plan view thereof;

FIG. 5 is a longitudinal cross-sectional view of the pipette tip with filter and tip fitting taken along the section line 5-5 in FIG. 2; and

FIG. 6 is a horizontal cross-sectional view of the tip taken along the section line 6-6 in FIG. 5.

DETAILED DESCRIPTION

The pipette tip shown in the drawing is a molded, one-piece structure typically made of polypropylene.

The tip body 10 includes a head 12, mid-section 14, and stem 16. A passage 18 extends axially throughout the length of the body 10 and is open at its upper end 20 and lower end 22.

The passage 18 is circular in cross-section throughout its length and generally diminishes in diameter from the upper end 20 to the lower end 22. The upper end 20 of the passage is provided with a counterbore portion 24, and the lower portion of the mid-section has a transition section 26 wherein the diameter of the passage 18 rather sharply diminishes as shown at 28. The taper of the passage 18 at portion 28 is substantially greater than the taper both above and below the transition section.

The head 12 of the tip is shown in FIGS. 1, 2, and 5 to carry a number of small vertical ribs on its outer surface. The ribs facilitate manual handling of the tip 10. The lower end of the head 12 is formed with a shoulder 30 by which the tip may be supported in a standard tip rack from which tips are loaded onto a pipette tip fitting as is well-known in the art. A tip fitting 31 is suggested in FIG. 5 on which the tip is frictionally mounted.

The advantages of the present invention are derived from its dimensions and capacity. As stated above, for maximum accuracy and repeatability in pipetting small volumes, the volume of the passage 18 in the tip should be as small as possible while accommodating the range of volumes to be aspirated by the tip. The smaller the volume of air in the tip between the top of the column of liquid drawn into it and the tip fitting on which the tip is mounted, the more nearly the pipette acts as a positive displacement pump in aspirating liquid from the tip. Therefore, the volume of the passage 18 for accuracy and repeatability of the pipetting action should be as small as possible. In addition to accommodating the volume of liquid to be aspirated, the mid-section 14 of the tip should provide room to accommodate a filter, as suggested at 36 in FIG. 5. The filter is provided for such purposes as avoiding aerosol contamination during the pipetting operation with successive fillings of the tip. The filter 36 also may act as a barrier to prevent the liquid from entering the pipette from the pipette tip when the liquid is subjected to turbulence as the instrument is being handled.

With respect to the head 12, it is desirable that the head diameter be as small as possible so that adjacent tip fittings in multi-channel pipettors may be moved as close together as possible to accommodate the minimum spacing between adjacent wells in microplates and other vessels. Adjustable multi-channel pipettors enable the fittings to be moved relative to one another to accommodate the particular application of the instrument. The smaller the diameter of the head 12, the closer together the tips may be placed during multi-channel pipetting. At the same time, the head must be large enough so as to facilitate stripping of the tip from the fitting by a stripper mechanism carried by the instrument as is well-known in the art.

As suggested above, the small volume pipette tip of the present invention has a capacity to aspirate volumes from .5 to 30 microliters. In order to be capable of dispensing volumes as small as .5 microliters, both inner and outer diameters of the lower end 22 of the stem must be very small as they dictate the minimum volume of a droplet that may be aspirated from the tip. The length and diameter of the stem 16 allows the tip to have access to the bottom of micro-centrifuge tubes. The stem must be long enough so as to prevent the instrument from entering the tube, and the diameter must be small enough so as not to interfere with the tip reaching the bottom of the tube while minimizing the liquid displacement of the tip in the tube. The capacity of the tip when used without a filter 36 is in excess of 30 microliters, and with the filter in place the capacity of the tip is approximately 16 microliters.

In order to achieve the various goals set forth above, the very small volume tip of the present invention has the following dimensions: The overall length L is approximately 1.600 inches; the height H of the head 12 is approximately 0.265 inches; the height H' of the mid-section 14 is approximately 0.245 inches; and the length L' of the stem is approximately 1.090 inches. The inner and outer diameters of the lower end 22 of the tip stem 16 are approximately .015 and .032 inches, respectively; the inner and outer diameters at the top 38 of the stem (at the bottom of the transition section 28) are approximately .045 and .105 inches; and the volume of the passage 18 within the stem is approximately 13.72 microliters. The inner and outer diameters of the top of the transition 28 are approximately .079 and .137 inches and the height H² of the transition is approximately 0.050 inches providing a volume in the passage 18 within the transition 26 of approximately 2.53 microliters. The head 12 in the preferred embodiment has a maximum outer diameter of approximately 0.216 inches and inner diameter of approximately 0.121 inches.

A pipette tip made in accordance with the dimensions set forth above has many advantages. The total volume of the passage 18 beneath the filter 36 exceeds 12.5 microliters allowing a very small volume of air above the column of liquid, and the volume of the column of liquid when no filter is used is approximately 30 microliters, also allowing a small volume of air for compliance beneath the bottom of the tip fitting 31 and the top of the liquid column. The tip can be used in a very wide variety of applications, and the thin wall of the lower extremity of the tip allows sufficient flexing so that "touching off" may be easily carried out.

Because variations may be made in the embodiment shown, it is not intended that the breadth of the invention be limited to the very specific configuration illustrated and described. Rather, the breadth of the present invention is to be determined by the appended claims and their equivalents.

Thus, it will be appreciated that the dimensions mentioned above and in the claims may be varied by

upto 5 or 10% and the volumes correspondingly.

Claims

1. A small volume disposable pipette tip comprising a one piece, moulded plastics body (10) having a head (12), mid-section (14) and stem (16) connected end to end with a continuous passage (18) extending throughout the length of the top and open at the top of the head (12) and the bottom (22) of the stem (16) said body (10) being approximately 1.6 inches (40.6mm) long and said stem (16) being approximately 1.09 inches (27.7mm) long and tapering in a downward direction with its maximum outer diameter at the top being approximately 0.105 inches (2.67mm) so that the stem will fit within a micro-centrifuge tube while minimising the volume of liquid displaced.
2. A small volume pipette tip comprising a one-piece moulded plastic body (10) having a head (12) mid-section (14) and a stem (16) connected end to end with a continuous passage (18) open at both ends extending therethrough, said stem (16) tapering in a downwardly direction and having an outer diameter at the top of approximately 0.105 inches (2.67mm) and a length of approximately 1.09 inches (27.7mm) and having a capacity of approximately 13.72 microliters.
3. A small volume pipette tip comprising a one-piece moulded plastic body (10) having a head (12) mid-section (14) and a stem (16) connected end to end with a continuous passage (18) open at both ends extending therethrough, said stem (16) tapering in a downwardly direction and said stem having a length of approximately 1.09 inches (27.7mm) and a capacity of approximately 13.72 microliters.
4. A small volume pipette tip comprising a one-piece moulded plastic body (10) having a head (12) at one end and a stem (16) at the other with a continuous passage (18) therethrough, said passage in the head being downwardly tapered for receiving a pipette tip fitting (31), said tip having a maximum capacity of approximately 30 microliters and a top length of approximately 1.600 inches (40.6mm).
5. A small volume disposable pipette top as defined in any preceding claim wherein the inner and outer diameters of the stem (16) at its bottom (22) are approximately 0.015 and 0.032 inches (0.38mm and 0.81mm) respectively.
6. A small volume disposable pipette tip as defined in any preceding claim wherein the inner diameters of the stem (16) at its top is approximately 0.045 inch-

es (1.14mm).

7. A small volume disposable pipette tip as defined in claim 1, 2 or 4 wherein the volume of the stem (16) is approximately 13.72 microliters. 5
8. A small volume disposable pipette tip as defined in any preceding claim wherein the head (12) is approximately 0.265 inches (6.73mm) in length for receiving a pipette tip fitting (31) in a friction fit. 10
9. A small volume disposable pipette tip as defined in claim 1, 2 or 3 wherein the volume of the stem (16) and midsection (14) together are approximately 30 microliters. 15
10. A small volume disposable pipette tip as defined in any preceding claim wherein the midsection (14) of the body includes a transition section (26) joining the midsection (14) to the stem (16) flaring outwardly and upwardly from the stem (16). 20
11. A small volume disposable pipette tip as defined in claim 10 wherein the combined capacity of the stem (16) and transition section (26) is approximately 16.25 microliters. 25
12. A small volume pipette tip as defined in any preceding claim wherein the maximum outer diameter at the top of the stem is approximately 0.105 inches (2.67mm). 30
13. A small volume pipette tip as defined in any preceding claim wherein the head has an outer diameter of approximately 0.216 inches (5.49mm). 35

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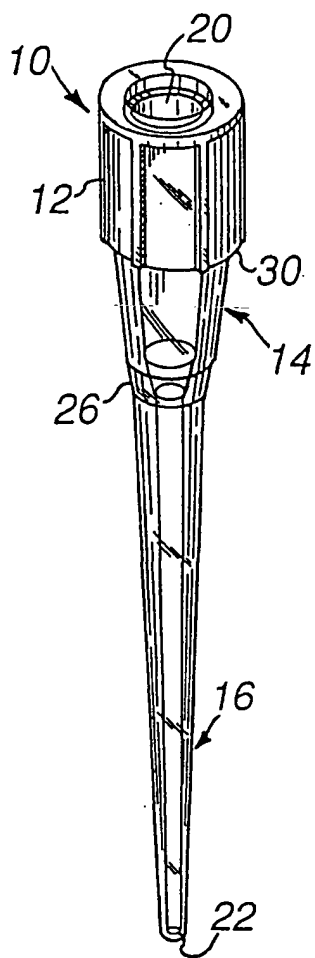


Fig. 1

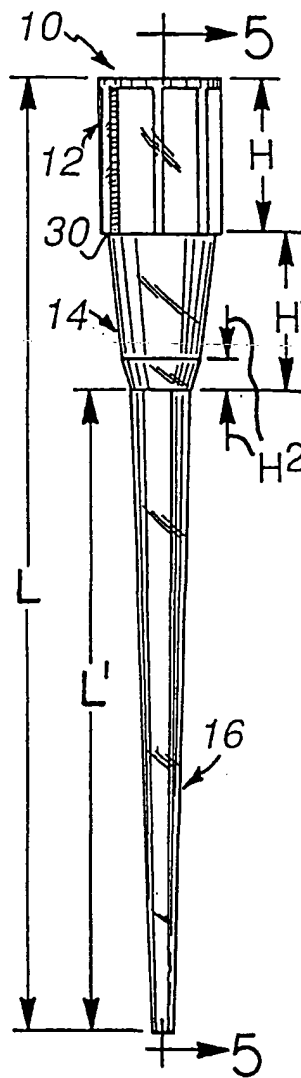


Fig. 2

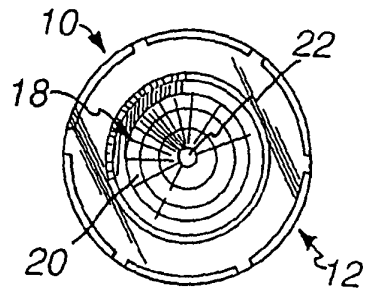


Fig. 3

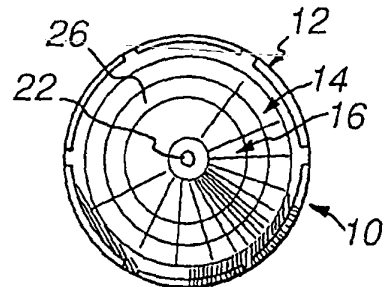


Fig. 4

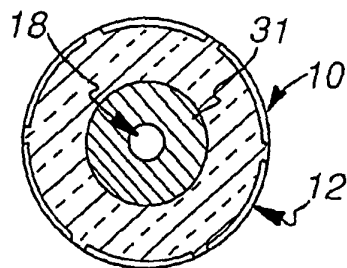
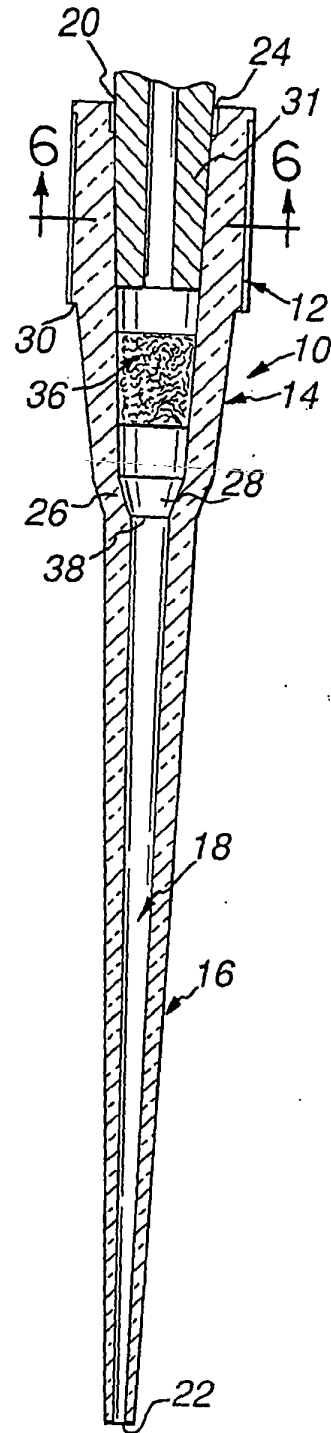


FIG. 6





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 96 30 3545

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	US-A-5 223 225 (GAUTSCH JIM) 29 June 1993 * column 5, line 59 - column 7, line 42; figures 2A,7 *	1-7,12, 13	B01L3/02
A	EP-A-0 562 358 (EPPENDORF GERAETEBAU NETHELER) 29 September 1993 * page 8, line 21 - line 37; figure 3 *	1-5,10, 12	
A	US-A-4 707 337 (JEFFS DAVID H ET AL) 17 November 1987 * column 4, line 38 - column 6, line 30; figures 5,6 *	1-5	
A	GB-A-2 172 218 (ROCKET OF LONDON LTD) 17 September 1986 * the whole document *	1-5,13	
A	US-A-4 824 641 (WILLIAMS FRED G) 25 April 1989 * column 7, line 20 - line 38 *	1-4	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			B01L
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 16 August 1996	Examiner Bindon, C
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document</p>			

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